POND MAINTENANCE

RESOLVING COMMON POND PROBLEMS

There are many problems that can reduce a pond's potential to produce a desired fishery. Most can be prevented with proper pond construction, development around the pond, and fish stocking, followed by proper management and maintenance. It is easier and less costly to prevent problems, rather than treat them later. But in some cases, such as decades-old ponds built with fishing as an afterthought, that is not possible.

Many pond problems are related to water quality. Whether the water is too green, too brown, or polluted, most water quality problems can be prevented by keeping sediment, nutrients, and pollutants out of ponds. Undesirable fish species, such as carp, bullheads, and gizzard shad, also need to be kept out of ponds since they can negatively affect water clarity and limit a pond's ability to produce sport fish.

The following information will explain the conditions that can lead to various pond problems, how to help prevent them, and how to resolve existing problems.

Water Clarity

The clarity of a pond is primarily determined by the abundance of individual, free-floating microscopic plants (phytoplankton/algae) and animals (zooplankton), organic materials, and suspended soil particles. If water is enriched with phosphorous, nitrogen, or animal wastes, a large algae bloom can occur, turning the pond green. See page 63 for vegetation control methods. If the pond was recently green in color, but quickly turned brown, the algae have died and are now decomposing. High populations of zooplankton or certain algae species can also give the water a brown color. A tannic acid buildup, resulting from the breakdown of accumulated organic materials from a marsh or wetland areas or from tree leaves in the pond, can stain pond water and give it the color of tea. When a pond contains non-transparent muddy water, it is the result of tiny particles of soil, especially clay soil, suspended in the water.

Extended periods of muddy water detracts from a pond's appearance, reduces food production for fish, eliminates aquatic vegetation and reduces oxygen.

Muddy water detracts from a pond's appearance and reduces its ability to produce food, especially for small fish, by shading the microscopic plant life on which the food chain is based. It also reduces the ability of sight-feeding fish, such as largemouth bass and bluegills, to capture prey. Extended periods of high turbidity can eliminate both submergent and emergent aquatic vegetation that provide important habitat for fish and other wildlife. Muddy water also has lower oxygen levels due to reduced photosynthesis. Sediment in the water can smother fish eggs and bottom-dwelling organisms. Although most ponds will be muddy following major inflow events caused by heavy rains in the watershed, the suspended sediment in good ponds should settle out within a week. Water in new ponds may be muddy until pond banks become vegetated; therefore, it is very important to establish and maintain vegetative cover around the pond as soon as construction is completed.

To correct a muddy water problem, the cause has to first be determined. Take a sample of pond water in a clear glass jar and set it on a shelf. If after one week the water is fairly clear and mud has settled to the bottom, the main cause of the problem is likely due to either soil erosion, wave action in shallow water, livestock, or an overpopulation of carp, bullheads, or even channel catfish; however, if the mud remains suspended, the problem is soil chemistry. Often the problem is a combination of several factors. In some cases the soil particles will stay suspended indefinitely.

Muddiness due to Soil Erosion

The best way to keep pond water clear is to prevent or reduce the amount of soil entering the pond from the watershed. This can be done by grading and terracing the land above the pond, installing sediment retention basins or soil traps at the pond inlet, routing muddy water around the pond through diversion ditches, and establishing buffer strips around the pond and in waterways leading into it. It is much easier to limit soil erosion and prevent excessive surface runoff than it is to remove sediment once it has entered the pond.

Reporting Excessive Runoff Problems:

If a landowner is experiencing excessive sediment runoff from a neighbor's property that may be in violation of Nebraska's Erosion and Sediment Control Act, the local NRD or NRCS offices should be contacted. If the excessive sediment runoff and/or suspected associated pesticides cause further environmental damages, such as crop loss or a fish kill, the U.S. Department of Agriculture's Plant Industry Section should be contacted within 24 to 48 hours at (402) 471-2394. The Nebraska Department of Environmental Quality's Agricultural Section should be contacted at (402) 471-4239 when problems arise from excessive runoff containing livestock waste.

Muddiness due to Wind and Animal Activity

If wind is causing shoreline erosion and waves are stirring-up bottom sediments in shallow-water areas, windbreaks should be planted to block prevailing summer winds and protect shorelines. Establish emergent aquatic vegetation, such as rushes, sedges, and cattails, and water-tolerant grasses, such as prairie cordgrass and switchgrass, along the shoreline and in shallow water areas, or by the dam if erosion is occurring there. These plants will facilitate healing of the shoreline and, in time, eliminate erosion. Rock rip-rap may have to be used along the dam if erosion is severe. Some of the shallow-water problems, including those on mudflats, can be resolved or avoided by deepening these areas, preferably during construction. Cover crops, such as millet, oats, or sorghum, can be planted in shallow areas or on excavated banks following construction or a drawdown to hold the soil in place during the filling process.

Turbid or muddy water in ponds is often the result of cattle activity in the pond or feeder stream. Cattle trample shoreline areas, causing the banks to erode. They also wade in shallow water, which destroys fish spawning and nursery areas and stirs up the mud. See page 23 on how to resolve water quality problems and habitat degradation associated with livestock watering.

When carp or bullheads are overpopulated, their feeding activity stirs up the bottom sediments. Eliminating the carp or bullheads and restocking with appropriate species will alleviate the problem. See page 55 for information regarding removal or control of unwanted fish species.

Muddiness due to Soil Type

Water that stays muddy is likely due to the type of soil in the watershed. This is the most difficult problem to resolve. Clay particles in suspension actually repel each other, rather than clumping together and settling out. Surface application of certain chemicals or organic matter causes a chemical reaction that makes the clay particles clump together and settle out. These treatments typically only provide temporary relief. The pond will likely become turbid again when the next major storm runoff event occurs. The sources of sediment should be eliminated through proper land management practices.

Ponds with chronic clay turbidity problems shouldn't be treated. Instead, they should just be stocked with channel catfish and minnows and provided with artificial feed, since turbid ponds produce limited natural food. See page 36 for further stocking and management information.

Chemical Treatments:

Alum (hydrated aluminum sulfate)

Alum is the most effective treatment to remove colloidal clay. If the water doesn't clear within a day after an initial application of 25 pounds per acre-foot of water, a second 25-pound application should be made. Alum causes the clay to flocculate and settle out. It also produces an acidic reaction. Alum should be dissolved in water and then applied on a calm day. Windy conditions cause mixing that prevents formation of floc and settling out. Alum should be sprayed over the pond surface from boat or shore. On large ponds, a dissolved solution can be sprayed or poured into the prop wash of an outboard motor. If the pond is acidic (pH below 7.0) or has soft water, a similar application of hydrated lime (calcium hydroxide) should be applied first to protect fish from the alum's acidic reaction. Occasionally, the liming process alone causes the clay particles to settle out.

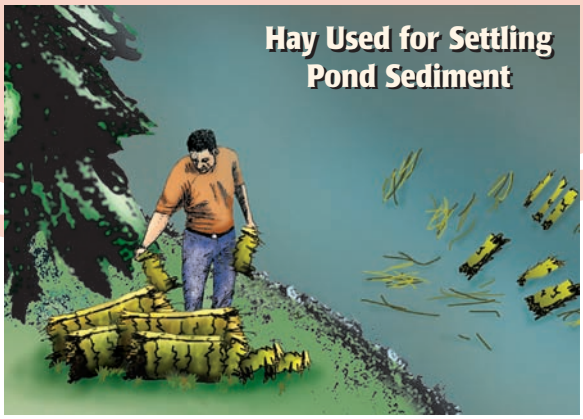
Agricultural Grade Gypsum (hydrated calcium sulfate)

Gypsum is also used to remove colloidal clay and is available at many fertilizer dealers; however, it is less effective than alum or hydrated lime. It can be applied at rates of 100 to 525 pounds per acre-foot of water. It can be applied in 100-pound increments, waiting a few days between applications, until the desired visibility is achieved. Gypsum should be applied by the same techniques described for alum. It has a neutral reaction in water and doesn't require a lime treatment. It also doesn't affect the use of treated water for livestock or aquatic plant and animal life in the pond. Finely ground agricultural limestone can be used as a substitute for gypsum and applied at a rate up to 500 pounds per surface acre. It can be applied using similar techniques as gypsum and it has a similar reaction and low environmental risks. Scrap sheet rock containing gypsum can also be used.

Organic Matter Treatments:

Hay Bales

Muddy water caused by suspended clay particles can sometimes be corrected by spreading broken bales of high-quality alfalfa, clover or prairie hay along the shallow, near-shore areas. About 100 pounds of hay (two small bales) should be applied per surface acre of water at 14 day intervals. As bacteria break down the hay, the resulting by-products form a weak acid, causing clay particles to clump together and settle out. Since decomposition uses up oxygen, this method shouldn't be used during the summer when water temperatures are high and dissolved oxygen levels are low or widely fluctuating. Dry hay bales should be used to facilitate a slower rate of decomposition. Monitor clarity changes. No more than 5 applications should be made during a year. This treatment is preferred over the use of alum or gypsum since it can increase a pond's productivity instead of decreasing it. Hay bales shouldn't be used in ponds with a history of fish



kills resulting from low oxygen levels unless an aeration system is present. Manure or weeds can also be used by utilizing similar application techniques and concerns as with hay.

Aquatic Vegetation Management

Although too much aquatic vegetation may interfere with fishing, boating, and swimming, vegetation is a very important component of the aquatic environment. It provides food, nesting sites, shade, and cover for a multitude of aquatic organisms. It also oxygenates the water and helps minimize shoreline erosion and wave action. Aquatic plants can become established naturally in a pond or they can be transplanted (see page 40).

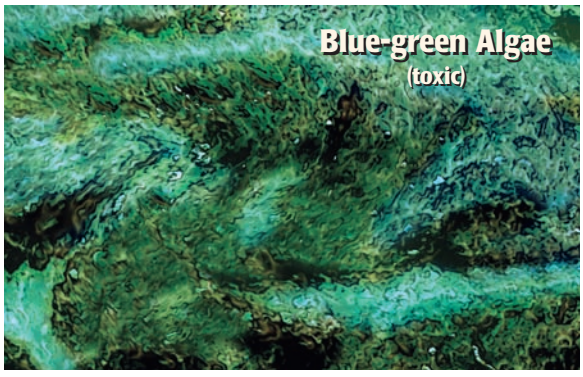
The presence of aquatic vegetation is good for your pond.

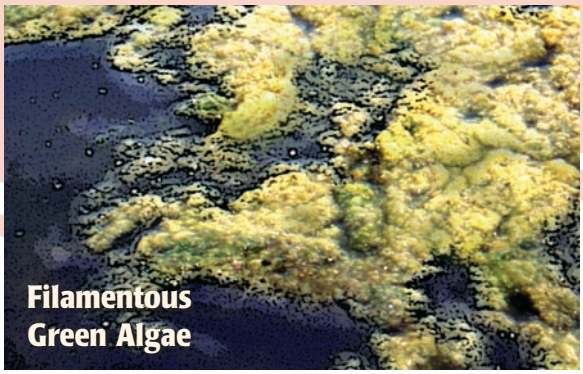
In some cases, excessive amounts of aquatic vegetation can ruin fishing and upset the balance between bass and bluegill by providing too many places for young bluegills to hide and avoid predators. Insufficient bass predation on bluegills will ultimately result in an excessive number of small, slow-growing bluegills, which will raid bass nests and limit the number of bass produced. Some species of aquatic plants can become so thick that plant diversity and associated wildlife diversity are both drastically reduced. Occasionally, die-offs of overabundant vegetation occur following cloudy weather, run-off events that muddy the water, or at the end of the growing season. If these die-offs are substantial, decomposition of the dead vegetation can deplete oxygen levels, which can stress or even kill fish.

Aquatic Vegetation Identification

There are four major types of aquatic vegetation, classified by their growing patterns: algae, floating plants, submersed plants, and emergent plants. Since the effect each can have on a pond and the best methods of controlling them differ, it is imperative that you correctly identify the vegetation type(s) if a problem should occur. For some control methods, such as the use of chemicals, it is necessary to identify the plant species in order to purchase the correct herbicide.

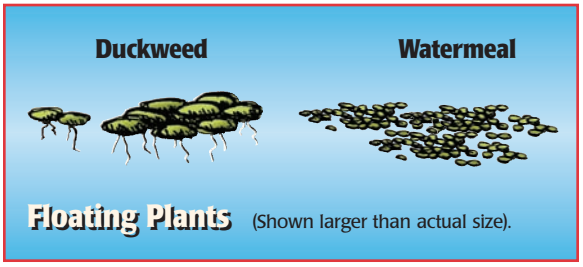
Algae are primitive plants without true leaves or flowers. Many are individual, free-floating, microscopic plants (planktonic) that can turn a pond green, making it look like pea soup or as if paint is floating on the surface. Others (filamentous) are found together in clumps or strands that are often attached to the bottom or aquatic structure. Some species of planktonic algae can be toxic or cause water to have a bad taste or odor. Several blue-green, bloom-forming planktonic algae species produce lethal toxins within the cell walls which are then secreted from living cells or released after death. These



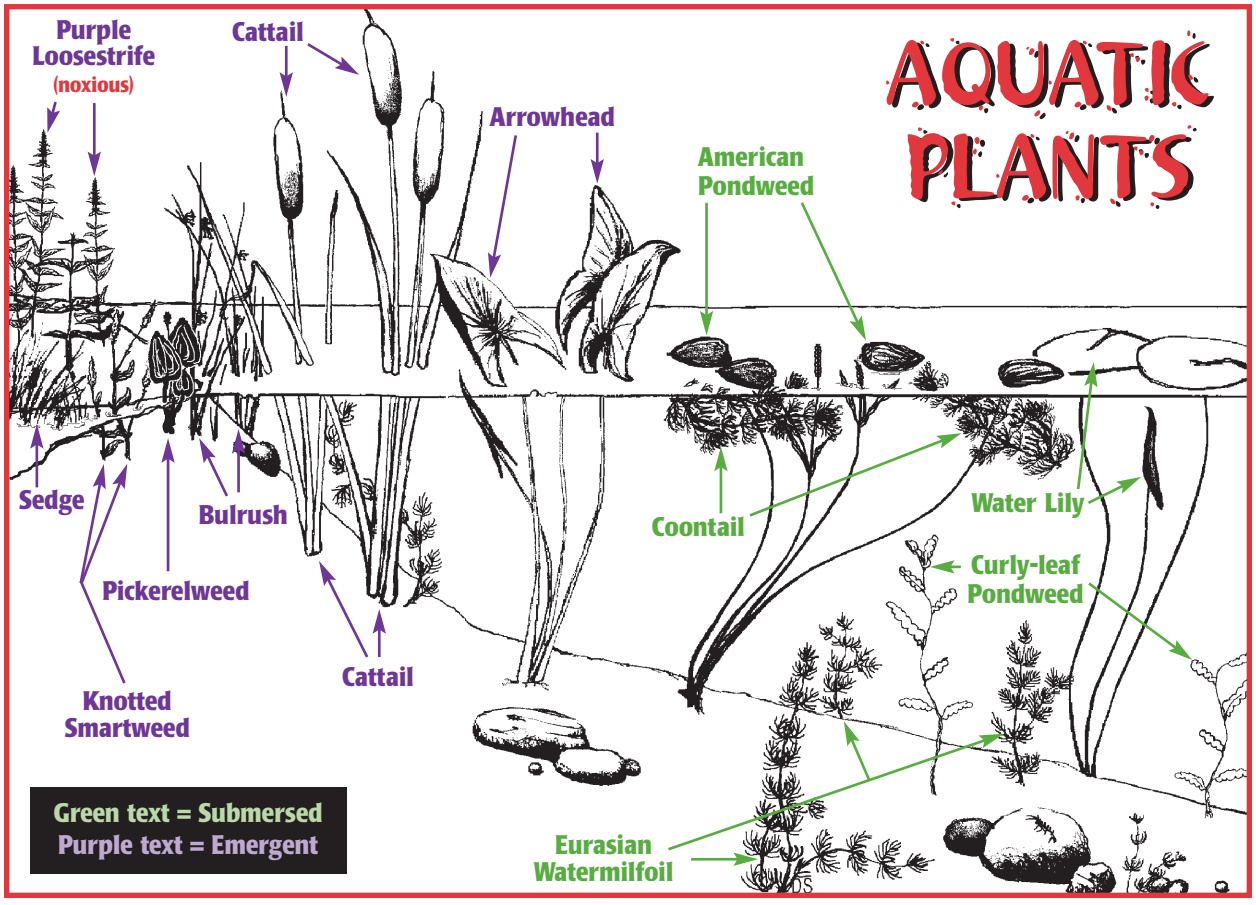


toxins can cause sickness, and even death, to pets, livestock, wildlife (especially fish), and humans. Filamentous green algae causes the most problems for pond owners. It is a stringy, hair-like plant, often called moss, that can form mats which can completely cover the pond surface. One type of algae, *Chara* spp., grows on the pond bottom and has stem and leaf-like features. They can be identified by their strong musty odor or gritty texture when crushed between fingers.

Floating plants are not attached to the bottom by roots. They float freely on the surface with roots hanging down in the water and move with the prevailing winds. Duckweed and the much smaller watermeal are common floating plants. They can become very abundant and cover the entire surface of smaller ponds protected from the wind.



Submersed plants are usually rooted to the bottom and grow upward to the surface of the pond. Their blossoms and seed pods extend above the water surface. The plant usually consists of a long flexible stem, with clumps of



narrow leaves along it. Surface leaves of some species look quite different than lower leaves. These plants can form thick beds that interfere with fishing, swimming, and boating. Examples are pondweeds *(Potamogeton* spp.), coontail, water milfoil, and water lily. Depending on water clarity, some of these plants can grow in water depths exceeding 10 feet.

Emergent plants are rigid, rooted to the pond bottom and extend upwards out of the water. They usually occur along the shoreline and grow in water depths less than 3 feet. Many emergents reproduce by seeds and rhizomes. Cattails are probably the most familiar emergent plants. Although they provide excellent shoreline protection and sediment entrapment, they are notorious for rapidly filling-in shallow areas of ponds. This can result in elimination of other desirable aquatic plants and limit shoreline activities such as fishing, wading, and boating. Bulrushes, sedges, smartweeds, arrowheads, and pickerelweeds are other common emergent plants. Trees, such as willow and cottonwood, are also included in this group. Purple loosestrife is an exotic emergent that can take over extensive shoreline areas and even entire wetlands.

Controlling Aquatic Vegetation

Aquatic vegetation can provide a variety of benefits. Although a particular level of abundance may be too much for one pond owner, it may be just right for another. As long as aquatic vegetation, primarily submersed type, isn't negatively affecting fish populations, especially largemouth bass, it can be allowed to cover 40% or more of the pond surface, depending on fish management goals. Once it gets above 40%, some may have to be removed to create open-water areas. Control for each vegetation type can involve one or more of the following techniques.

Depending on fish management goals, aquatic vegetation can cover 40% or more of a pond's surface.

Prevention

Prevention is the best control. Follow depth and slope guidelines presented earlier to reduce the amount of shallow-water areas where plants can grow. Utilize wise land use practices that prevent soil erosion and keep nutrients on the land and out of the water. Prevent animal wastes from entering – either construct a sewage lagoon to catch feedlot and barnyard runoff or divert it around the pond through a grass-lined ditch when permissible.

Physical or Mechanical Removal

The physical removal of aquatic vegetation from a pond is a valuable control technique. This is done by cutting or uprooting rooted plants and removing them from the pond. Floating plants can be collected with seines and removed, especially on windy days when the plants are concentrated along one shoreline. Plants can be removed by hand with simple tools or with special cutting machines. In shallow shoreline areas, plants can be pulled by hand, cut with a sickle, dug out with a shovel, or removed with a rake or a chain pulled through the pond behind a tractor or ATV. Undesirable plants should be controlled when they first show up, before they get a chance to spread extensively. Remove as much of the plant's roots as possible, when applicable.

For larger ponds or deep water, commercial power cutters are a more sensible option. The most important part of mechanical control is to remove the cut plants from the pond. Many aquatic plants can grow from plant fragments, so cutting one stem in half doubles your problem. Fragments that don't grow will decompose and release nutrients that stimulate other plants to grow. The decomposition process also uses up oxygen and can cause fish kills. Removing the vegetation from the pond removes all the nutrients stored in them, reducing the likelihood of future problems. Removing plants mechanically or physically provides only temporary relief and may be practical for only a small portion of the pond. The processes will likely need to be repeated

several times throughout the growing season and in subsequent years.

Chemical treatment should be kept to a minimum.

Chemical Treatments

If you are unable to determine a source of nutrients, or if you still have vegetation problems following nutrient reduction and removal efforts, chemical treatments can then be considered. Many herbicides that control aquatic vegetation in ponds are available from commercial distributors. Most are listed as restricted use and must be applied by a licensed aquatic pesticide applicator.

Some advantages of herbicides are:

- They generally produce fast results.
- They are usually easy to apply.
- They are often available locally.
- They are normally selective for a particular type of vegetation.
- They give the pond owner control over how much vegetation is eliminated.

Some disadvantages of herbicides are:

- They are expensive.
- They usually require multiple applications to maintain control.
- They can be dangerous to the applicator and aquatic animal life if applied incorrectly.
- The plants must be correctly identified, sometimes to species.
- The treatment area must be accurately measured.

Rarely does the entire pond need to be treated.

Typically, all that is needed is to open up some fishing and boating lanes or a few shoreline areas for bank fishing, swimming, and wading. If a large portion of the pond surface will eventually be treated, or the growth is extensive, treat only 1/4 to 1/3 of the problem area at a time, and wait about two weeks between subsequent applications. If too much vegetation is killed, its decomposition will deplete available oxygen which can stress or even kill fish. Most problem vegetation species should be treated early in the season when they first start growing, not during summer months when the dissolved oxygen levels in the pond may already be low or widely fluctuating. Some plants, such as cattails and water lilies, should be more mature when certain chemicals are used; otherwise, only the top will be killed and the rest of the plant and its roots will be unaffected and regrow. Keep in mind most aquatic plant species die-off naturally at the end of their growing season and regrowth of new plants from plant fragments, root stock, and seeds is likely.

Read and follow the directions and precautions on the herbicide label. The label will list what plants can be controlled, dosage recommendations, and when application should occur. Also listed on the label will be any restrictions on usage of treated water, including human contact (swimming, wading, or drinking the treated water), fish consumption, irrigation and livestock watering. Check the pond water temperature. Some chemicals will not work in cold water.

Try to avoid applying chemicals during fish spawning periods.

Most aquatic herbicides will not harm fish if properly applied. Some chemicals can directly or indirectly kill spawning adult fish that refuse to leave treated areas, and they may kill fish eggs or fry. Some herbicides, such as copper sulfate used for algae control, should not be used extensively in fishing ponds. Because it is cheaper and perhaps easier to apply than chelated copper-based chemicals, there is a tendency to over-apply copper sulfate. This can negatively affect fish and their food organisms as it disperses through the water column. Chelated copper-based chemicals are less harmful to fish, less corrosive, and are more

effective in hard water. They also persist longer in the water. This longer uptake period provides better control of algae and means less chemical is needed, as compared to copper sulfate.

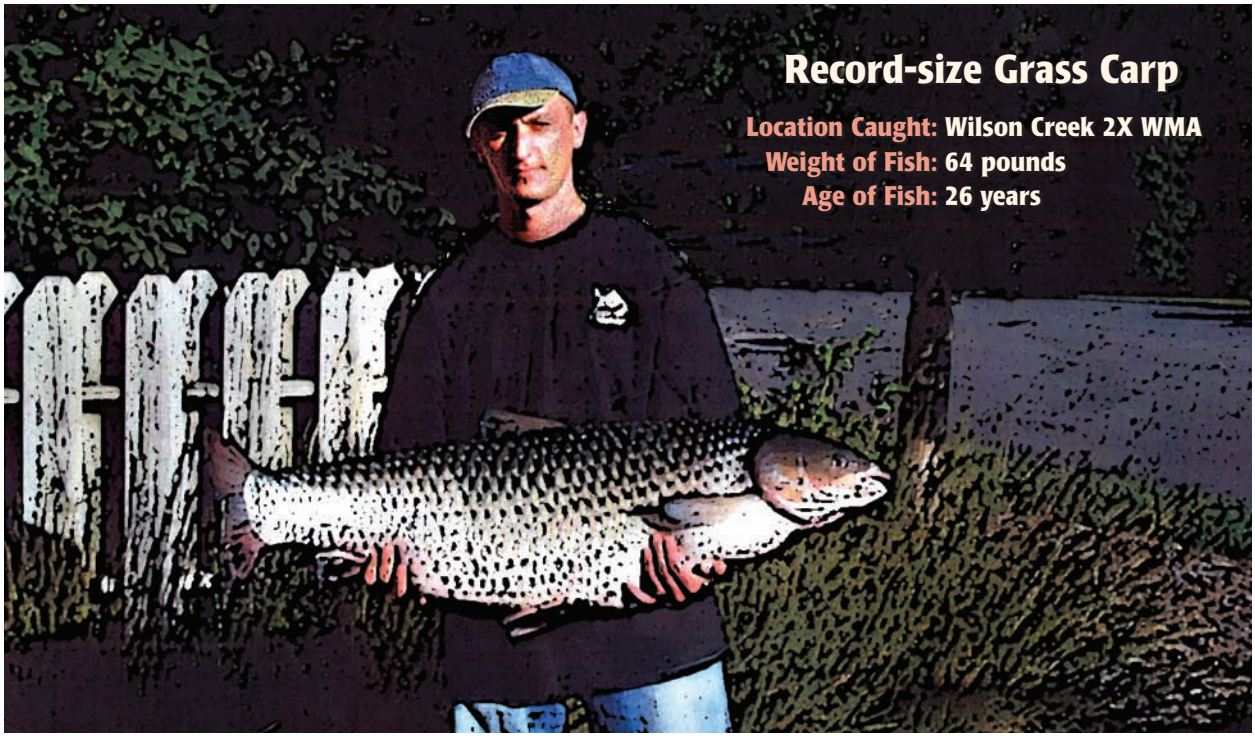
Most chemical applications involve calculating a dosage per acre-foot of water that has a vegetation problem. Examples of surface and volume calculations are provided in Appendix C. If you are uncertain about plant identification or herbicide usage, contact an area Commission fisheries biologist or the extension educator in your county.

Biological Control

The grass carp, also known as white amur, is a plant-eating fish native to Asia that has been introduced in the U.S. for aquatic vegetation control. Grass carp should never be stocked in a new pond, nor should they be stocked if there is only a narrow band of vegetation around the pond edge because they will eliminate critical habitat for bluegill and largemouth bass. They feed almost exclusively on aquatic vegetation, eating two to three times their weight each day during the summer months. Grass carp are grazers and prefer certain types of vegetation, eliminating them before they consume less-palatable or smaller species. They are not successful in controlling milfoil, coontail, watermeal, duckweed, pond lilies, or most algae species, especially *Chara* spp. Grass carp are very inefficient in converting food into body tissue. Their excrement is high in nutrients, which promotes the production of more vegetation. Too many grass carp can result in total elimination of the desirable submergent vegetation that was utilizing or tying up available nutrients. This can result in planktonic algae blooms.

Grass carp can live for decades. Once they are stocked in a pond, it is virtually impossible to remove them without killing everything in the pond or draining it. Since the pond owner has no control over which plants grass carp eat or how much they eat, they are rarely, if ever, recommended for vegetation control. Spot treatment with chemicals is a better option.

Since grass carp are long lived, they should not be used; instead, spot treat with chemicals.



If a pond owner insists on stocking grass carp, they should be stocked at a density of no more than 5 per surface acre of vegetation coverage to control plants or 15 per acre to eliminate them. Always start at a low stocking density and add fish as needed. Stocked fish should be at least 10 inches long to prevent immediate predation by largemouth bass and birds. It may take two to three years before plant growth is reduced. Since grass carp require large rivers to spawn successfully, they may need to be restocked at less than 5 per surface acre every five years to compensate for natural mortality and the likelihood some may have been flushed-out during high water flows. Restock only when vegetation is causing a problem again.

Contact UNL Cooperative Extension staff about algae identification and control.

Barley straw can be used as a biological control for algae. It is normally applied at a rate of 225 pounds per surface acre of water. As the straw decomposes in the pond, it produces a growth-inhibiting chemical that will prevent new algae growth but may not kill off what is already present. For this reason, it should be applied in March or April, before the algae starts to grow. Barley straw doesn't work on all kinds of algae. The first step is to properly identify which species you have. If this isn't possible, experiment with a algae sample taken from your pond. Place it, along with an adequate amount of pond water, in a large tub or tank. Apply barley straw and determine if control occurs. It may take 2 weeks to see any results, longer if the water temperature is below 68 degrees. Depending on the availability and cost of barley straw and the size of your pond, it may be easier to just do the treatment if you had major algae problems in the past, and then monitor results. Keep in mind the decomposition process uses oxygen, which will reduce oxygen levels in the pond and stress or kill fish if the straw is over-applied.

Although many algae species are important food items for zooplankton, high density levels of algae are considered undesirable and somewhat difficult to control. If algae blooms keep recurring once control measures have been tried and gizzard shad are present in high numbers, the shad need to be controlled or eliminated. Shad are very efficient filter feeders and can decimate zooplankton populations that naturally feed on various algae species.

Pond Liners

Covering the pond bottom with perforated plastic sheeting or fine mesh landscaping fabric can effectively prevent rooted vegetation from growing. The fabric also limits nutrient exchange between the pond bottom and the water. Plastic sheeting 4 mm or thicker should be weighted to keep it in place and perforated to allow gases to escape from the pond bottom. Large sections of window screen can also be placed on top of submerged plants and weighted down. This will compress and shade the plants, which should cause them to die in a couple of weeks. The process can then be repeated in another area.

Water Level Manipulation

Lowering the water level of a pond can be an easy way to control unwanted aquatic vegetation. Pond drawdown, especially during the winter, can dry out plants and expose them to harsh conditions, including freezing temperatures, wind, and sediment compaction. For winter control to be effective, the bottom mud should freeze to a minimum depth of four inches for at least a month. Dead plant material should be removed from the pond basin as soon as possible, definitely before refilling, so their nutrients are not released back into the water. Make sure the pond still has sufficient depth (10 to 12 feet) during the winter months to prevent a fish kill.

Cattails can be effectively controlled by lowering the water level, cutting or shredding the plants, and then flooding them during the winter. They will drown, provided the roots are

kept completely submerged for an extended period of time, especially during the following growing season, and there is no attached top growth remaining to funnel air down to the roots.

Dredging and Deepening

Many vegetation problems can be eliminated by deepening shoreline areas. Creating a 3:1 slope to a depth of 4 to 5 feet, and then tapering off rapidly into greater depths will limit where vegetation can grow. At least 25% of the pond's surface area should contain a depth of at least 10 feet, 12 feet in northern and western parts of the state. Dredging, or partially draining the pond and excavating, reduces vegetation problems directly by removing the plants and bottom sediments, and their associated nutrients.

Shading

Limiting the amount of sunlight available to aquatic plants with dyes that stain the water is another vegetation control method sometimes used by pond owners. Too much chemical shading, however, can reduce the pond's overall productivity, including fish production. To be effective, the dye must persist in the water for several weeks. Ponds with constant flow may not be good candidates for this technique. For best results, dye should be used early in the spring before the vegetation starts growing. If the plants have already grown to the surface, it's too late to add dye. Floating objects such as piers or swimming platforms may shade a small area of the pond and prevent vegetation growth. Or, pond owners can anchor black plastic sheeting on styrofoam floats around swimming areas or boat launches to shade specific areas.

Fish Kills

Fish populations in a pond are constantly experiencing mortality. Some can have an annual mortality rate as high as 50%. Most of these deaths can be attributed to natural causes, with predation being the most common. It is also common to see some dead fish along shoreline areas. These fish likely died as a result of old age, minor disease outbreaks, handling, or spawning stress. Contrary to popular belief, fish kills are rarely caused by an overpopulation of fish. A pond will naturally stay within its capacity to support fish under normal conditions. Common causes of fish kills are suffocation due to lack of oxygen, poisoning, and disease or parasite infestations. Knowing about these causes can help pond owners prevent fish kills.

When large numbers and a variety of sizes of different species are found dead, a major fish kill has occurred.

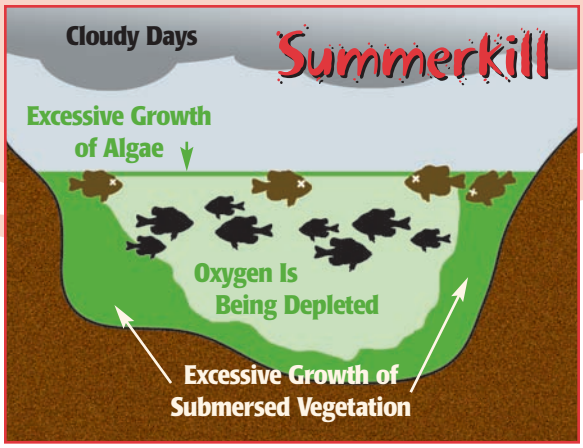
Fish Kills due to Suffocation

Most of the dissolved oxygen in a pond is a product of plant photosynthesis. Oxygen can also enter the pond by absorption through the water surface, especially when there is wind and wave action. Dissolved oxygen levels can vary significantly throughout the year or even during a day. Critically low dissolved oxygen levels can result from certain combinations of environmental conditions and pond characteristics. Low dissolved oxygen is the most common cause of fish kills in ponds, often occurring in summer, winter, or as a result of seasonal water column turnover. Once levels reach a critically low point, only aeration or the addition of fresh aerated water can prevent a fish kill.

Summerkill

Summer fish kills can result in the total or partial die-off of a pond's fish community. This type of fish kill is most common in small, shallow, heavily vegetated ponds containing a large amount of decomposing organic material. Summerkills can occur when certain environmental conditions cause a substantial decline in dissolved oxygen levels.

Excessive vegetative growth, especially algae, in a pond can lead to a fish kill. Sunny conditions result in a long period of plant photosynthesis that produces high dissolved oxygen



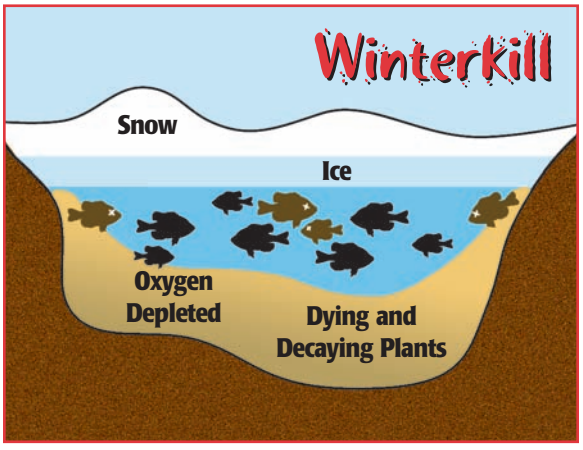
levels during late afternoon; however, during the night, oxygen is used for respiration by plants, fish, insects, and other organisms, and organic decomposition. If the oxygen produced during the daytime is insufficient to carry all pond life through the night, a fish kill will result. As long as the weather is sunny, oxygen production is usually adequate. However, several consecutive calm, cloudy days can result in vegetation dying (especially algae) and decomposing, reducing the pond's dissolved oxygen levels to the point that fish may not survive the night. These conditions are confounded during the summer when air and water temperatures are greater than 80 degrees and calm conditions prevail. A summerkill usually results in larger fish dying first, with minimal, if any, effect on other aquatic animal life, such as aquatic insects, frogs, and turtles.

The most obvious sign of an oxygen problem is fish gasping or gulping at the surface, particularly in the early morning hours.

Ponds can become stratified during the summer, particularly those protected from the wind. Water density varies according to temperature, with the colder, denser water occurring at the bottom. The surface water normally has sufficient dissolved oxygen, while the denser bottom water may contain little or no oxygen because it is depleted by bacterial decomposition of organic matter. This is especially true in ponds with excessive vegetation. The differences in water densities keeps the pond water from mixing. But, a rapid inflow of cool surface runoff from a summer thunderstorm, combined with strong winds and waves, can result in mixing the surface water with the oxygen deficient bottom water. During this thermal turnover, or inversion, a fish kill can result. Lightning strikes can also cause a fish kill in the immediate impact area.

Winterkill

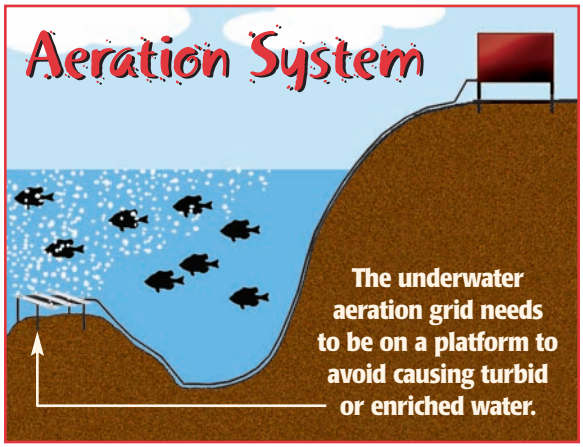
Winter fish kills result when oxygen levels fall too low to support fish under the ice. Since ice acts as a seal and prevents the absorption of oxygen directly from the atmosphere, oxygen produced by plant photosynthesis is crucial. Clear, thick or even cloudy ice typically allows enough sunlight penetration for plants. But, ice blanketed with snow allows very little sunlight penetration, so plants are unable to produce a sufficient amount of oxygen. Oxygen levels drop due to plant decomposition and respiration by the various aquatic organisms. If snow cover persists for an extended period of time, the oxygen will be completely depleted, resulting in a fish kill. This usually happens in shallow ponds which have large amounts of organic matter, such as decaying aquatic vegetation or livestock wastes. Winterkills can be severe enough to kill all the fish and other aquatic life, including frogs and turtles, in a pond. Often, bullheads and carp



are the only fish to survive winterkills. In these cases, the pond should be renovated with rotenone and restocked with appropriate pond species, provided adequate depth is present.

Seasonal Turnover Kill

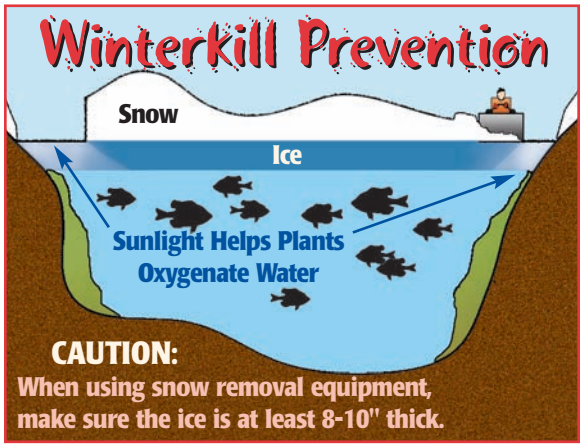
Some ponds that contain relatively large amounts of deep water that annually stratifies can experience a fish kill when the pond turns over, producing conditions similar to an inversion. These ponds thoroughly mix in both spring and fall when surface and deep water temperatures are the same. Wind can facilitate the mixing.



Preventing Fish Kills due to Suffocation

Most of these fish kills can be avoided if a pond contains sufficient depths to prevent excessive growth of aquatic vegetation and to store enough oxygen during critical time periods, especially winter. Proper pond construction and management can prevent these fish kills.

These types of fish kills can also be prevented by installing an aeration or water circulating system that will oxygenate the water year-round. Do not allow the aerator diffuser (air stone) to rest on the pond bottom as this will stir up organic materials, accelerating their decay and increasing oxygen consumption. Algae blooms can result if large amounts of bottom nutrients are carried to the surface as the bubbles rise. Either place the diffuser on a pedestal or in a weighted 5-gallon bucket, or suspend it at least two feet off the bottom. Both systems will maintain an open water area during the winter and facilitate oxygen absorption directly from the atmosphere. Cutting a single large hole in the ice during the winter isn't very effective because not enough water gets exposed to the air. See *Appendix D* for additional information on aeration.



Winterkills can also be prevented by removing snow from the pond. Three inches of ice, covered by five inches of snow, will block 99% of the incoming sunlight. Remove snow from 30 to 50% of the pond surface or just in shoreline areas where submergent vegetation would be located beneath the ice.

Fish Kills due to Poisoning

Fish kills can be caused by the improper use or spills of many chemicals, including insecticides, herbicides, fertilizers, and petroleum products. Pesticides can enter a pond from an agricultural field, golf course, or lawn. Some pesticides can be very toxic to fish. Luckily, many are short-lived and usually break down and become non-toxic to fish before they enter a pond. Many pesticides can cause a fish kill when applicators are careless and allow the spray or its drift to enter the pond directly. A fish kill can also occur when storm runoff carrying pesticide-laden soil particles enters a pond immediately after an application.

Fish kills resulting from chemical poisoning can be extensive and affect all fish species.

They are also characterized by small fish dying sooner than larger fish. Many species of aquatic vertebrates, such as turtles, frogs and tadpoles, and other aquatic organisms, can also be killed or adversely affected. If sub-lethal pesticide dosages continue to enter a pond for an extended time period, they can affect fish food production, alter fish reproduction, or become an additional stressor that decreases fish resistance to low dissolved oxygen levels and diseases. By choosing a proper site for pond construction, many of these problems can be avoided. Landowners also need to consider pond health when choosing chemicals to use in the watershed.

Fish Kills due to Diseases and Parasites

Fish kills can also result from disease and parasites. Although viruses, bacteria, and fungi can all cause disease outbreaks, they usually do not result in massive fish die-offs. Mortality can occur during early spring, when a fish's disease resistance is low due to winter and pre-spawning stressors. If fish populations are out of balance and there is a high density of one species of fish, particularly crappies, a disease outbreak can result in a substantial fish kill. Angler caught fish that are mishandled during the release process are more susceptible to infections and diseases. Environmental conditions, such as prolonged periods of low dissolved oxygen, extreme pH levels, and high temperatures, can also stress fish and make them more susceptible to diseases. Although most fish have some parasites, they are normally not a problem for healthy fish. Like diseases, parasites can cause mortality if fish are already stressed from other factors. Maintaining good water quality and balanced fish populations will keep fish healthy and less susceptible to disease and parasite problems. See page 73 for additional information on fish parasites and diseases.

Consequences of Fish Kills

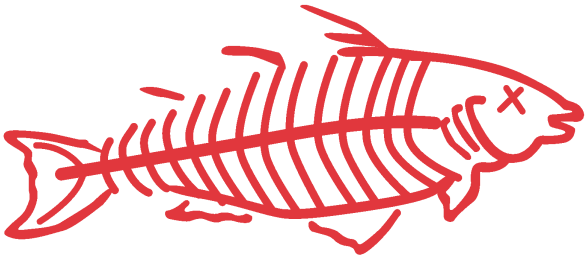
Most fish kills do not result in elimination of the entire fish community. The severity of a fish kill depends on environmental conditions, the size and depth of the pond, and the type of kill. The adverse conditions that caused the kill may not have occurred throughout the entire pond, and unaffected areas will provide a refuge until conditions improve. For example, a partial kill caused by pesticides associated with storm runoff may occur in the area near the inlet and nowhere else, as a result of dilution.

Fish populations that have suffered die-offs should be assessed to determine what needs to be done to restore the pond's fishery. See page 50 for further details on assessing fish populations.

Depending on the severity of the fish kill and the species involved, the remaining fish populations may not return to previous levels or provide the same quality of fishing. If undesirable fish species, such as carp, bullheads, or green sunfish, were present prior to the kill and were not affected by it, they may then overpopulate the pond due to reduced competition and lack of predation by largemouth bass.

Diagnosing and Preventing Fish Kills

The following information can be used as a guide for troubleshooting fish kills in ponds. Knowing what can cause a fish kill will help you prevent or lessen the severity of one.



CAUSE of FISH KILL	SYMPTOMS	PROBLEM	RECOMMENDED SOLUTION(S)
Summerkill	Fish found dead and/or gasping for air at the surface, particularly in early morning hours; larger fish usually die first, little effect on other aquatic animal life (frogs, turtles, etc.).	Consecutive days and nights of cloudy, hot, still conditions; very high water temperatures (above 85 degrees) and not enough dissolved oxygen; cloudy skies prevent plants from producing oxygen; calm winds prevent mixing of oxygen into surface water; aquatic organisms' respiration and plant decomposition deplete available oxygen; shallow, weedy ponds are especially vulnerable.	Add fresh water and/ or agitate the water surface to facilitate oxygen absorption; deepen pond to limit vegetation growth and increase water volume so more dissolved oxygen can be stored and/or install an aeration system.
Inversion	Dead or gasping fish (larger fish affected first) found after a violent thunderstorm which produced heavy downpours and high winds.	Large sudden inflow of cool rainwater and strong winds cause bottom water (low in dissolved oxygen) to mix with the surface water, resulting in critically low oxygen levels throughout; can occur in shallow, weedy ponds or ponds that contain deep, stratified, stagnant water; both types in combination with large, steep drainage areas with high runoff rate; lightning can also cause a fish kill, affecting all fish species of all sizes in the immediate strike area.	Install an aeration system to circulate and aerate oxygen deficient bottom water and/or deepen shallow water areas to restrict vegetation growth.
Seasonal Turnover	Dead or gasping fish (larger fish affected first) found in spring and/or fall	Stratified and/or unoxygen-ated deep water mixes with surface water in spring and fall when surface and deep water temperatures are the same, resulting in critically low oxygen levels; wind can facilitate the mixing.	Install an aeration system to circulate and aerate oxygen-deficient bottom water.

CAUSE of FISH KILL	SYMPTOMS	PROBLEM	RECOMMENDED SOLUTION(S)
Phytoplankton Die-off	Fish found dead and/or gasping for air at the surface (larger fish affected first); water has a green cast or looks like it has paint floating on the surface prior to or during fish kill, or water may have a brown color during or after kill.	Nutrient enriched ponds produce dense blooms of phytoplankton (algae) which can suddenly die-off following consecutive days and nights of cloudy, hot, still conditions; decomposition causes an oxygen shortage; dead and decomposing algae can release a toxin fatal to fish into the water and/or give a brown color to the water.	Reduce nutrient inputs by diverting nutrient enriched runoff from animal feedlots or cropland around the pond and/or install nutrient/sediment entrapment structure(s) above the pond.
Dead Vegetation	Fish found dead and/or gasping for air (larger fish affected first) within a few days of a die-off of large amounts of aquatic vegetation.	Massive die-off of aquatic vegetation from aquatic herbicide overuse; or muddy water from storm runoff enters a pond and prevents sunlight penetration, resulting in suffocation and die-off of aquatic vegetation; large amounts of decomposing vegetation depletes available dissolved oxygen.	Shoreline should be sloped 3:1 and additional deep water areas created to limit vegetation growth; reduce nutrient inputs; consider an aeration system if unable to deepen or reslope shoreline areas.
Organic Pollution	Fish found dead and/or gasping for air (larger fish affected first) following inflow of large amount of organic matter after heavy rains.	Large amounts of decomposing matter (excess animal wastes, leaves and vegetation) deplete dissolved oxygen levels.	Prevent excess organic matter from entering or building up in the pond; use aeration to accelerate the decay process and reduce buildup.
Winterkill	Large numbers of fish of all sizes along with turtles, frogs, and other organisms found dead along shoreline soon after ice-out; few, if any, fish caught by anglers in spring as compared to the previous year.	Snow cover stays on the ice for an extended period of time, preventing sunlight penetration to plants that produce oxygen; aquatic organisms' respiration and plant decomposition deplete oxygen; shallow, heavily vegetated ponds are especially susceptible.	Remove snow if its depth is greater than 3 inches from at least 30% of pond surface and/or install an aeration system to prevent complete ice cover.

CAUSE of FISH KILL	SYMPTOMS	PROBLEM	RECOMMENDED SOLUTION(S)
Toxic Substances	Dead or dying fish (smaller fish affected first), frogs, tadpoles, and insects.	Pesticides, petroleum products, fertilizers, and other toxins enter the pond directly or when heavy rains wash recently applied chemicals into the pond; extent of the kill depends on the amount and dilution rate of toxins upon entry to pond (problem may be confined to just entry site).	Divert runoff coming from potentially toxic sources; install entrapment structures or buffer strips; if pesticide application is necessary for crop production, apply carefully.
Natural Causes	Some dead fish (usually larger and older fish) found along the shoreline in early or late spring.	Natural mortality caused by reduced disease resistance brought on by winter and/or spawning stressors.	Nothing, let nature take its course.

Reporting Fish Kills

Contact the nearest Commission district office, the Nebraska Department of Environmental Quality (NDEQ), (402) 471-2186, or the 24-hour NDEQ/State Patrol pollution complaint hotline, (402) 471-4545, regarding fish kills that may be due to toxic substances. Contact a district fisheries biologist or the Private Waters Specialist in Lincoln to discuss extensive fish kills and their consequences.

Fish Parasites and Diseases

A healthy fish can tolerate some parasites with little ill effects. Black spot and yellow grub are two common fish parasites found in ponds. Yellow grubs can be found beneath the skin of largemouth bass, bluegills, and other fish. Commonly found in bluegills, black spot are tiny flukes imbedded in the skin and flesh. Both of these parasites have no effects on humans, so infested fish are safe to eat. In addition, the parasites are killed when the fish are thoroughly cooked, hot smoked, or frozen. If grub infestation is low, the parasites can be removed from the flesh if family members are squeamish about eating them. If the flesh is heavily infested, it might be impossible to remove all the parasites; getting the cook to prepare it and the family to eat it may also be difficult.

It is not practical to remove parasites from a pond. Pond owners must simply learn to live with them. Of the more than 1,000 species of North American freshwater fish parasites, only a few are known to infect man and those have not been found in Nebraska. The life cycles of black spot and yellow grub involve different developmental stages that require host organisms such as fish, birds, and snails (see diagram). One technique that might reduce the abundance of these grubs is stocking snail-eating redear sunfish.

Pond fish are sometimes affected by a fungus (*Saprolegnia* spp.). This grayish, cotton-like growth is usually a secondary infection on fish that have experienced a disease or are stressed by some adverse environmental condition.

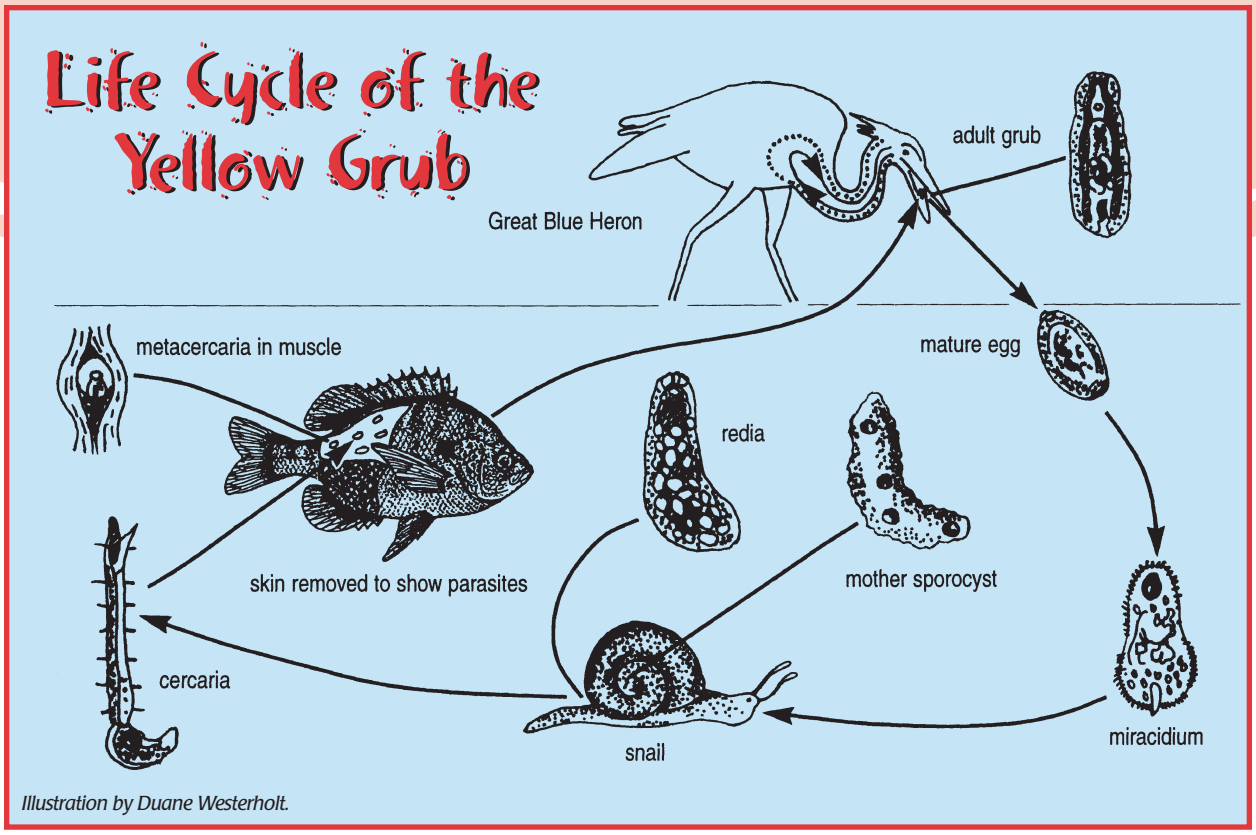


Illustration by Duane Westerholt.

Many times it is seen on the tail, sides, or belly of fish which have rubbed these areas while spawning or on fish that have been mishandled. Some affected fish will die, but most will recover.

A protozoan *(Ichthyophthirius* spp.), often called "ich", can be very harmful to fish. Many aquarium owners are familiar with this fish-killing parasite. The elimination of ich from a pond is virtually impossible, so prevention is important. By maintaining good water quality in the pond and only stocking healthy fish, ich should not be a problem.

Bacterial diseases are common in all fish and occur most often when environmental conditions, such as water quality, are poor. Inadequate oxygen levels in the pond can stress fish and make them susceptible to bacterial infections. These infections are often associated with spring die-offs in ponds. As the water warms in the spring, fish weakened by the stress of winter can be affected by bacteria and die. Spring spawning activity adds another stress to weakened fish that can increase the number of deaths. The loss of fish to bacterial infections is fairly common in May and June. There is no treatment available for bacterial problems, but fortunately the problem is rarely severe.

Fish secrete a protective mucus coating which helps prevent fungal and bacterial infections. If this coating is damaged during the spawning process or as a result of mishandling by an angler, the fish becomes more susceptible to infection. The mucus coating is less likely to be damaged if a hook is removed while the fish is still in the water, or if the angler wets his or her hands before handling the fish and gently releases the fish, instead of tossing it into the water.

Extensive disease outbreaks or parasite problems are rare, usually occurring when a particular fish species approaches its carrying capacity. Follow recommended stocking rates and strategies and you shouldn't have any problems. In catfish- or wiper-only ponds and some backyard ponds, where fish are kept and fed at a high density, diseases are much more common. In these situations, special medicated feeds may prevent serious problems.

For more information on the state's more common fish diseases and parasites, contact the Commission and request a copy of "What's Bugging That Fish? An Angler's Guide to Fish Diseases and Parasites".

Shoreline Erosion

Most ponds will be protected from erosion by establishing well-vegetated shorelines. Where grass or aquatic vegetation isn't sufficient to protect a shoreline, rock rip-rap should be used. Football-sized rocks or pieces of broken concrete can be placed along the dam, or other eroding shorelines, several feet above and below the water line. A steep, eroded bank may first have to be graded and engineering cloth laid to create a stable base for the rip-rap; otherwise, erosion could persist and possibly cause rip-rap to collapse into the pond.

Logs, rocks, or trees, placed several feet out in the water and parallel to shore, will absorb the energy of waves and prevent shoreline erosion, or facilitate healing of eroded areas. Emmergent plants and willows should be used to expedite healing. During early spring, root-stock from emergent plants can be dug up, cut or pulled apart into sections (two nodes/new shoots per section) and planted in combination with 18-inch long willow sections between the shoreline and wave-absorbing materials.

Willow Plantings for Shoreline Stability

Leaking Ponds

Some water loss can be expected in new ponds until the basin and immediate shoreline become saturated. In older ponds, a 6-inch to 1-foot loss due to evaporation during a dry month is normal. If your pond loses more than a foot of water in a month and there is no withdrawal of water from the pond or nearby well, you should look for a leak. Ponds usually leak through a porous layer of sand, gravel, or broken rock extending under the dam. The water may come to the surface some distance below the dam. If you find places below the dam that are often soggy, even in dry weather, investigate further. The seepage could be due to a spring, unrelated to your pond. Leaks are difficult to locate. If the water level stops dropping, you can assume that the leak originates at or above that water level and efforts to seal the leak can be concentrated there.

Pond dams with a well compacted clay core tied into an existing clay substrate rarely leak. One cause of leakage is a failure to place anti-seep collars along drainpipes through the dam. These collars prevent water from seeping through the dam alongside the drainpipes.

The best way to avoid pond leaks is to choose a good site and use proper dam construction techniques.

Repair of a leaky dam or pond bottom often is difficult, expensive, and usually requires draining the pond. Adding a blanket of clay or bentonite to the bottom normally seals leaks. A bulldozer can be used to remove material in a problem area and then add and compact 1 to 2 feet of soil that has a high clay content. Bentonite can expand up to 20 times its original size when moistened. For best results, bentonite should be spread evenly over the dry pond bottom at 1 to 3 pounds per square foot of pond bottom (the higher amount in deep water areas and sandy soils), mixed into the top 4 to 6

inches of existing soil with a disc, moistened, and then compacted with a roller. If feasible, a layer of clay can then be placed over the bentonite/soil mixture. Keep in mind a bentonite sealed bottom will crack and likely leak if the water level drops and it is exposed to air.

Ponds may also be sealed by installing a liner of flexible plastic or rubber sheeting made of polyethylene, vinyl, or butyl at least 2 mm thick. To protect against punctures or tears, the pond liner should be covered by at least six inches of fine clay soil. Livestock can also be used to seal a pond. When fenced into the dry basin for several months, their activity will compact a mixture of soil, manure, and waste feed into the bottom, sometimes producing a seal. Once a repaired pond fills, livestock need to be excluded or their hooves may break the seal or puncture liners.

An emulsion of oil-soluble resinous polymers can be used to seal a pond without draining. The effectiveness of this material varies with condition and character of the soil, water, and climate, as well as the manner of application. It is expensive and toxic to fish, but a pond can be restocked a few days after the water has cleared. Spreading a bentonite slurry or granular bentonite uniformly across the pond surface can also form a seal. This is often less successful than an application to a dry pond because of uneven settling onto the bottom.

The NRCS can help determine the best way to stop leaks based on the soil types found at your pond. You can also contact the Private Waters Specialist or area Commission district office for a list of companies and products available for pond sealing.

Filled-In Ponds

As they age, ponds accumulate sediment, debris, and decaying vegetation, eventually becoming marshes, and finally dry land. Ponds that have filled with sediment through the years can be rehabilitated, but the process is expensive. If you wish to deepen the existing pond, you can remove sediment with a drag line. A cheaper method is to drain the pond by breaching the dam with a backhoe or to pump it dry. Once the pond has dried for several months, the bottom should be firm enough that a bulldozer or backhoe can be used to remove sediment from the basin. Compacted layers of clay should be used to patch a breached dam. Soil should also be pushed up against the pond side of the dam to ensure the dam is resealed. Contact your local NRCS office to discuss the feasibility of breaching your dam.

It is often easier to build a new pond if a good site is available, rather than restoring an old one.

Non-Fishing Ponds

Perhaps your old pond is no longer suitable for producing viable bluegill, largemouth bass, and channel catfish populations and you do not want to spend the time or money to correct environmental problems. The pond can still be managed in ways to provide enjoyment or possibly profit. Some of these uses are:

- raising crayfish, salamanders, or minnows for bait
- providing habitat for frogs, turtles, snakes, and assorted bugs and birds
- creating a marsh or waterfowl area.

Raising koi is another option for small ponds, particularly backyard ornamental ponds. Koi are a fancy version of the common carp. Through years of breeding, hobbyists have produced an amazing array of color variations and patterns on these fish and no two look exactly alike. Raising them can be a fascinating and relaxing hobby or they can even be entered into contests. Koi will reach 18 inches in 3 to 4 years and a maximum length of about 3 feet. The average life span of koi is 25 to 35 years, but some live much longer. Koi ponds should be aerated and filtered constantly, cleaned regularly, and heated in the winter (a stock tank heater works well). They should be fed pelleted feed once or twice a day. In many ways, having

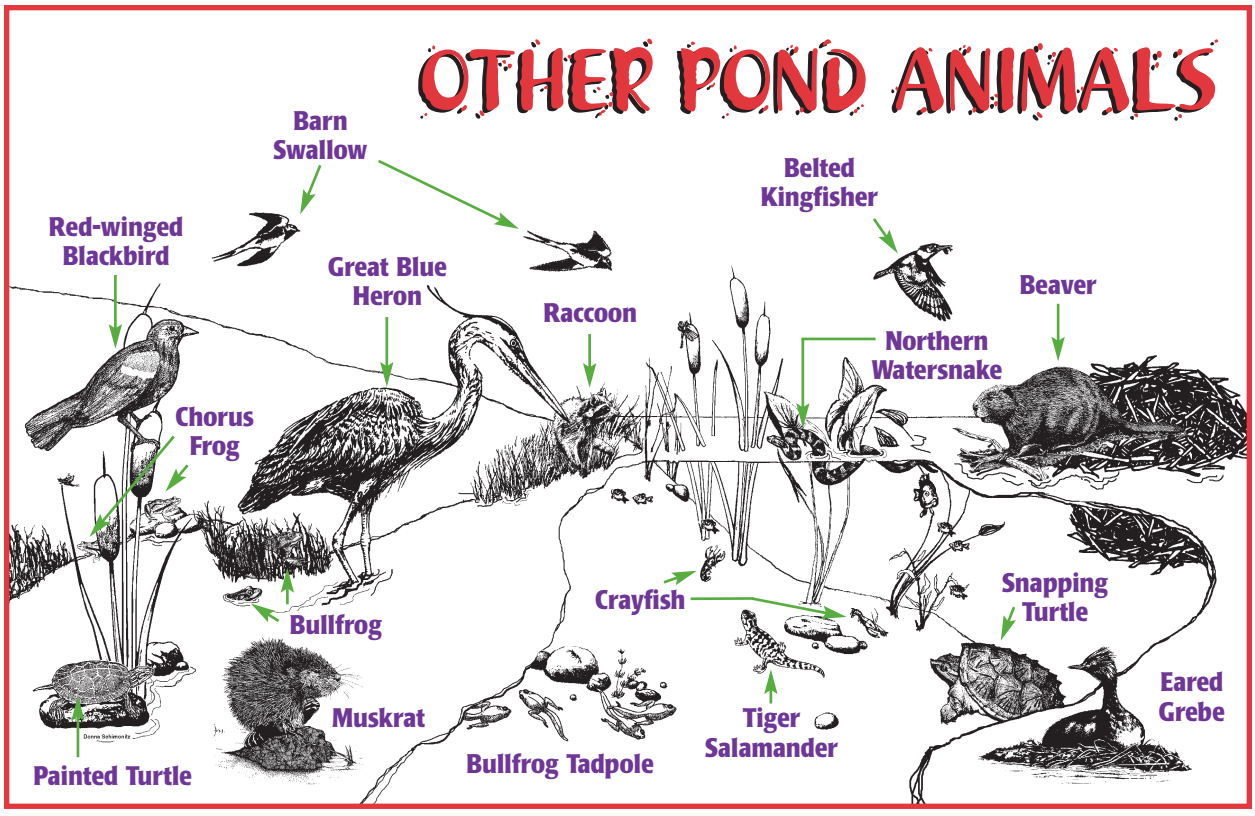
a koi pond is a lot like having an outdoor aquarium. They are popular among suburban residents with no land for a fishing pond. Pond kits and supplies are now sold in many large pet, garden, and home improvement stores. Koi can be costly. Goldfish are less expensive and just as hardy.

Mosquito control in backyard ornamental ponds or small waters can be accomplished by stocking fathead minnows, small bluegills, or green sunfish to consume the larvae. Keep in mind that fathead minnows can reproduce in these smaller ponds, and possibly attain a high enough population to interfere with water quality and any other fish species present.

Other Pond Animals

A pond will attract various kinds of animals throughout the year. If the pond is properly designed and maintained, most wildlife will cause little harm. Those that do become a nuisance may have to be controlled. The following information can be used to determine if control is necessary.

Turtles are common in ponds, not harmful to fish populations, and should not be killed without good reason. Common pond residents are the snapping, painted, and occasionally, soft-shell turtles. Turtles are scavengers that feed primarily on aquatic plants, along with insects, frogs, crayfish, and dying or dead fish. Fish on a stringer are an easy meal. Snapping turtles may also capture small ducklings. When turtles are in the water, they are shy by nature and will avoid larger animals, including anglers and swimmers. Snapping turtles are good to eat and can be caught with a baited bank line or by rod and reel, or even harvested with archery equipment. For the adventurous, they can also be caught by hand, even in early winter. Snapping turtles can often be spotted in shallow water under the ice. Because of the cold temperatures, they are very lethargic so you can chop or drill a hole in the ice and grab them by the tail. If turtles should



become a nuisance and authorization is obtained from the Commission, they can be captured with homemade traps that allow entrance only from above the water surface. Traps should be set in shallow weedy areas and baited with fish heads, watermelon rind, or fresh meat.

Snakes do eat fish, but do not pose a threat to fish populations. Water snakes are harmless to humans and should not be killed. Clearing debris and mowing the pond edges in areas used frequently by the pond owner and invited guests reduces hiding places for snakes and will reduce their numbers.

Crayfish are not harmful to fish populations. Some crayfish species build burrows that may cause leaks in a small dam that has limited free-board. Crayfish overwinter in their burrows in the bottom mud or pond banks and become active when water temperatures are above 40 degrees. Crayfish are good to eat and they can be used for bait. They are most active at night and traps can be set in late afternoon and left out overnight. Regulations require crayfish traps be made with one-fourth inch square mesh material with a length of 24 inches or less, a diameter of 16 inches or less, and a throat opening of one inch or less in diameter. Traps can be baited with fish heads, meat scraps, dog food, or soybean cakes. Crayfish are readily eaten by trout, bass, and catfish. Maintaining a balanced fish population is the best way to control crayfish numbers.

Beavers are rodents that build lodges in open water or on land near water. The lodge is usually dome-shaped and is built of sticks and mud. Lodges usually have one or two under-water entrances. The den inside the lodge is above water and is used to raise young, for sleeping and some food storage. If the water level rises and remains high, these rodents will burrow upward and construct a new dry den close to the soil surface. It may even break the surface or be close enough that the den caves in easily. This damage to the den encourages them to dig further. If a beaver den is located in the dam, burrowing can then weaken it and cause dam failure during major storm runoff events. Placing rock rip-rap 2 feet above and 3 feet below the water surface on the dam will discourage beaver burrowing.

Most damage caused by beavers is a result of dam building and tree cutting. They often plug drainpipes in ponds, resulting in loss of water level control and damage to the emergency spillway. Hog-panel or electric fencing can be used to keep beavers away from outlet tubes. Although beavers prefer trees such as poplar, green ash, willow, and pine, they will eat the bark, twigs, and leaves of most woody plants growing near water. The best way to prevent beaver damage to trees is to wrap chicken wire around the base of the tree. Beaver also eat corn, soybeans, and other crops.

If beaver activity is jeopardizing the stability of the dam, outlet tube, or emergency spillway, they should be controlled. The use of traps is the most effective, practical, and environmentally safe method of controlling them. Contact the Commission for information regarding trapping regulations, depredation permits, and a list of depredation trappers in your area.

Muskrats construct lodges in open water or dig tunnels to their dens in the bank or dam. The tunnels are dug both above and below the water surface and can threaten the integrity of a dam. Rising and falling water levels could eventually cause a dam containing muskrat tunnels and dens to leak or fail. Placing rock rip-rap on the face of the dam will also discourage muskrats from digging. One-inch mesh wire screening is also effective in deterring burrowing along the dam.

Cattails, arrowhead, and other vegetation form much of this rodent's food. Removing the food source will discourage muskrats. Keeping the pond banks mowed also limits their activities.

Muskrats can be driven from the dam by placing a half cup of mothballs in holes drilled at 3 foot intervals along the face of the dam near the water's edge. The holes should be sealed

shut with soil after the mothballs have been added. Nuisance muskrats can also be controlled by trapping, either during the trapping season or after obtaining a depredation permit.

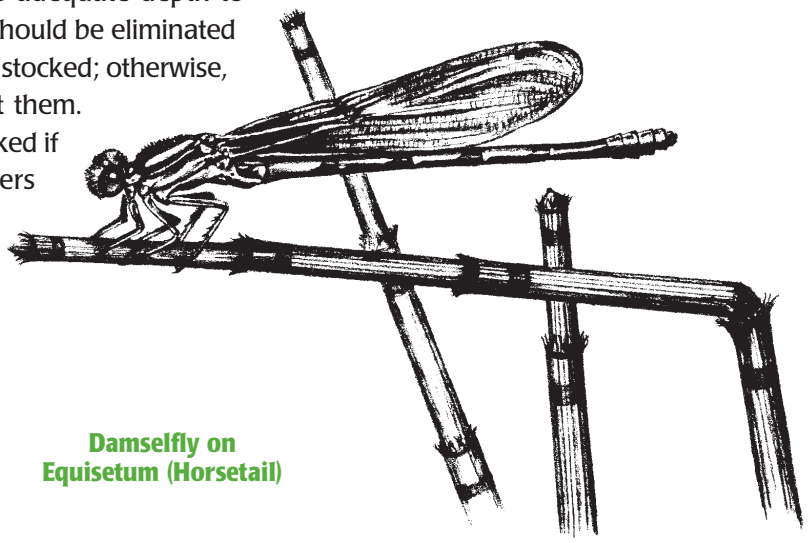
Frogs need water to reproduce and thus are common in ponds. Gelatinous masses of frog eggs can be found attached to vegetation along shallow shoreline areas during the spawning season from spring through early summer. Maintaining good shoreline vegetation cover is important for all life stages of frogs. It also provides them protection from terrestrial and aquatic predators.

Frogs do not have a negative or positive affect on a fish community. Some frog species are quite mobile and adults may not stay at a pond, but bullfrogs usually make a pond their permanent home. The bullfrog is the only species that has a tadpole stage lasting longer than a year. Bass and other predators will feed on frogs and keep their numbers in check. Consult fishing regulations regarding possession or harvest of bullfrogs.

Salamanders also need water to reproduce. They normally are not common in ponds containing fish, especially if predators, such as largemouth bass and catfish, are present. High numbers of salamanders in a pond normally indicates the pond is too shallow to sustain a viable fishery or that no fish have been introduced yet. If a pond contains a high number of salamanders and has adequate depth to support sport fish, they should be eliminated before fingerling fish are stocked; otherwise, the salamanders will eat them. Adult fish should be stocked if removal of salamanders isn't feasible.

Waterbirds, such as terns, gulls, herons, kingfishers, cormorants, pelicans, and grebes, are attracted to ponds. While many will eat fish, they rarely consume enough to affect fish populations; however, a high concentration of pelicans and cormorants on a small pond can greatly reduce fish populations. Some of these birds are intermediate hosts for the black and yellow grubs. While they are often thought to carry fish or fish eggs from one pond to another, it has never been documented. These birds, like snakes and turtles, are normally beneficial predators that remove weak or diseased fish from a pond. Some of these birds can also help control nuisance pests such as leeches and snails.

Other birds that frequent ponds, such as swallows, purple martins, and kingbirds, are effective in controlling pesky insects, such as mosquitos and biting flies. Nearly all birds are protected by state and federal laws and should not be killed or discouraged from feeding or nesting around ponds. Although a pond will also attract migrating waterfowl, pond owners near metropolitan areas across the state and all pond owners east of Highway 14 should not feed or encourage them to nest. This is especially true for Canada geese. They can become over-abundant and cause health and water quality problems. See page 46 regarding additional information on waterfowl.



Damselfly on Equisetum (Horsetail)